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ART. I.—*The Influence of Oxygen on the Human System.* By D. P. GARDNER, M. D., Lecturer on Chemistry, New York, &c. No. 1.

IN this paper I propose to consider the influence of oxygen gas on the changes natural to the human body, and in future communications, the results of those changes.

1. The discovery of Dr. Scherer, that the azotized proximate principles of plants and animals are identical, is the most important fact in physiology. The processes of digestion and nutrition hang upon it. But it has not only simplified our doctrines in regard to these two important functions, but also offers a solution of the still more recondite subject of the metamorphosis of tissues.

From the remotest antiquity, it has been asserted that the being of to-day is altogether distinct from the individual of twenty years back. Nutrition and repair have been abundantly investigated, but the waste of tissue, muscles, and glands has been neglected as beyond our reach. That constant death of parts which maintains the energy of the whole, has been too unpromising or humiliating a subject for physiologists. The dogma of Buffon, so grossly misrepresented and little understood, that the larger animals are accretions of the lower, is again appearing in a more philosophical dress to throw light upon the functions of the animal frame. Each molecule of the body, endowed with its proper life, passes through a cycle of existence without drawing with it the destruction of the machine of which it is an integrant—nay, further; that machine is endowed with new attributes by the arrangement of its minor parts. So a single cell in plants, (*Chlorococcum vulgare*), is capable of inhaling gas and fluid, of decomposing carbonic acid in the sun's light, and forming chlorophyl, and starch and albu-

men, but it has not all the properties of united cells; it cannot lay down an enduring trunk.

2. The analysis of vegetable fibrine from wheat, and fibrine of blood gave Scherer

(C) Carbon=	54.603 and 54.454
(H) Hydrogen=	7.302 and 7.069
(N) Nitrogen=	15.809 and 15.762
(O) Oxygen=	} 22.285 and 22.715.
(S) Sulphur=	
(P) Phosphorus=	

Numbers which, those familiar with the results of organic analysis will perceive, indicate perfect similarity of composition. These numbers have been reproduced in the researches of Mulder, Boussingault, Varentrap, Will, and Jones. It is not true of fibrine only, but the albumen and casein of animals and vegetables are identical. But of the two kingdoms, vegetables only possess the property of forming out of inorganic matter, such important substances. This function of plants upon which animal existence depends, is in its turn dependent upon the action of the sun's beams. By their quickening influence the frail cellules of an humble weed can destroy the chemical affinities of the atoms of carbonic acid, which no galvanic battery can effect, and uniting the carbon with water, lay the foundation of these nutritious bodies. Some fungi are, indeed, eminently nutritious, although growing without light, and beneath the surface of the soil, as the truffle (*Tuber cibarium*), but these are secondary organizations, depending upon the presence of organic matter in the earth—the destroyers rather than the producers of vegetable principles.

3. The animal machine being incapable of forming fibrine, depends for its supply upon plants, and by their ingestion it enters the stomach. Its fate therein cannot be discovered from all the works on physiology previous to the time of Scherer. So sublime did the mystery of digestion appear, that those medical men who have not kept pace with the advance of chemical knowledge, can hardly be persuaded that it is no more than a case of solution. Fibrine digested, which they would have termed fibrine vitalized, animalized, chymified, made fit for the nutrition of human beings, is, indeed, in our day no more than *fibrine dissolved*.

By what route we care not, by lacteal or absorbent, it reaches the blood, and there Mulder and Scherer prove that it is no more than the identical fibrine which we trace in a vegetable juice, or the seeds of the cerealia.

4. Passing with the current of blood along the circulation, ever ready to put on the insoluble form as soon as the chemical requisites to its solubility are disturbed, each atom ultimately reaches its place of destination in the system. Imprisoned in a capillary, which allows no further progress to the denser parts of the blood, one principal condition of the soluble state, *motion*, is arrested, and fibrine reaches its appointed station to form one monas of a complex animal. Nutrition is no more, in this case, than precipi-

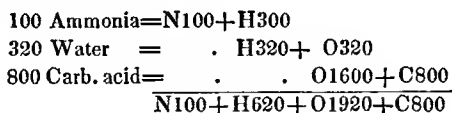
tation, for Playfair and Boeckmann show that the composition of blood and the bodies produced therefrom are similar.

But the position occupied by the newly added molecule is not fortuitous—certain forces having guided its career, and they continue to control its destiny. These are nervous power and vitality, or that collection of actions which physiologists are pleased to call vital, because unable to separate into their components.

5. The place of deposit, wherever it may be, forms part of a perishable tissue—the fibrine becomes subject to the law of the structure. As an independent body, it might have retained its form for ever if removed from the agency of moisture and oxygen—or it might have experienced decomposition in a few minutes. But its fate is now determined by the necessities of the system—this condition remaining, however, that in its complete decay the same agents are required and the same products generated.

6. Fibrine decaying in atmospheric air is surrounded with an abundance of oxygen gas and moisture; its resulting products are dependent upon these conditions. To place the study of this decomposition in a clear light, I shall adopt the atomic constitution of fibrine—Carbon 800, Hydrogen 620, Nitrogen 100, Oxygen 240, Phosphorus 1, Sulphur 2, with 0.77 per cent. of sulphates and phosphates of lime and magnesia. (Kane.) Under the freest supply of oxygen, and in circumstances producing slow decay, all the carbon would form carbonic acid, all the nitrogen would unite with hydrogen to form ammonia, and the hydrogen in excess, would form water.

Thus, the atom of fibrine, omitting the sulphur, phosphorus, and saline matters, would be resolved into



and for the change 1680 atoms of oxygen are required more than the fibrine contains. This perfect eremacausis would, however, occupy much time, and requires a slowness of decay, foreign to azotized matter. The truth is, that although the preceding products would be formed, if the conditions were maintained—yet in the destruction of such bodies the decomposing forces are of too active a nature to give time for the amount of oxygen necessary to become absorbed, and new but feebler affinities between carbon, nitrogen, and hydrogen come into operation.

If the fibrine decays under the influence of fermentation, which is an active process, the compounds of carbon, hydrogen, and nitrogen, are produced much more freely. Cyanogen, carburetted, sulphuretted, phosphuretted hydrogen make their appearance as well as ammonia, water and carbonic acid—not in virtue of a specific operation, but because the ratio between the rapidity of decay and absorption of oxygen is altered. Just as the difficulty of procuring oxygen increases, the production of hydrogen

compounds increases, and in those situations where it cannot be absorbed, hydrogen compounds only are formed.

It is this law of nature which has secured to our race the invaluable mineral *coal*. If the vegetable matter from which it has been produced, had been abundantly supplied with oxygen, during decay, every atom of carbon would have become carbonic acid. But as soon as the atmosphere was excluded, all change ceased with the last portions of hydro-carbon formed, leaving nearly pure carbon in anthracite.

7. In the human body, the atom of fibrine, now a molecule in a muscle or other organ, suffers death or decay under similar laws. If we turn our attention to the ejected products of animals we discover in *health* an entire absence of compounds of hydrogen with carbon, sulphur and phosphorus—these bodies I have said mark the want of oxygen, and are the result of rapid decay or fermentation. The living body does not, therefore, in rejecting its effete parts adopt under normal circumstances a fermentative process. Neither does it proceed by a perfect oxidation or eremacausis, for we are aware of the generation of compounds of nitrogen with carbon. What then is the character of the change?

8. We can obtain a knowledge of it only by considering the products resulting. In the discussion of extra-animal decay, the character of the decomposition is known by studying the nature of the bodies generated; this is also the method in investigating the ultimate metamorphosis of tissues.

All the normal constituents of the animal frame, may be classed under the distinct heads of fibrine, or protein compounds and fats. We may simplify our discussion without the remotest shadow of error, by leaving the latter bodies out of view, and regarding only the protein class. Again, we may confine ourselves to fibrine as a representative of the whole class, and by determining its changes, argue fully and correctly to that of every portion of the frame. Omitting partial transformations into chondrine, hair, gelatine, arterial membrane and secretions so ingeniously discussed by Liebig, I will proceed at once to the perfect metamorphosis of fibrine into effete matter.

9. The excreting organs, whereby the products of decay are thrown from the system, are the kidneys, lungs, skin and cutaneous glands. They are not to be confounded with the secreting glands, the liver, spleen, testes, parotids, thyroids, salivary, pancreas, mammæ, mucous exhalents, &c. In which list I have included several structures whose office is unknown, but it is certain from their situation that they are not excretors. The liver, pancreas, and salivary glands have thus been considered by some, but improperly, for the saliva is an important adjunct to digestion; the liver and pancreas, by throwing their secretions into the unabsorbed chyle, are evidently intended to alter the form of substances which have passed through their structure, and fit them for a return into the animal economy.

Nor is the discussion affected by our ignorance of the office of many glands. The constitution of expired air is no matter for cavil; the composi-

tion of urine, and the character of cutaneous excretions are known, and this knowledge is sufficient in itself to furnish us with the history of every particle of fibrine that suffers decay.

10. Searching in the urine for some of the products of decay, we learn that principally azotized and saline matters are drained off from the system by the kidneys;—those azotized bodies which have reached a state of metamorphosis that not only unfits them to remain in the tissues of the body, but renders them injurious to health. They must not be confounded with such fluids as have only reached a partial change, as bile, (C37, H66, N5, O22,) and contain nitrogen, and are subject to further decay, before thrown out of the system as effete.

11. The exact nature of the urinous azotized matters, will be seen in the accompanying analysis of urine by Berzelius (*Chemie*, t. vii. p. 392).

Water	-	-	-	-	-	-	933.00
Urea	-	-	-	-	-	-	30.10
Uric acid	-	-	-	-	-	-	1.00
Lactic acid and lactate of <i>ammonia</i>	-	-	-	-	-	-	17.14
Mucus	-	-	-	-	-	-	0.32
Sulphate of Potash	-	-	-	-	-	-	3.71
Sulphate of Soda	-	-	-	-	-	-	3.16
Phosphate of Soda	-	-	-	-	-	-	2.94
Biphosphate of <i>ammonia</i>	-	-	-	-	-	-	1.65
Chloride of Sodium	-	-	-	-	-	-	4.45
Muriate of <i>ammonia</i>	-	-	-	-	-	-	1.50
Phosphate of lime and magnesia	-	-	-	-	-	-	1.00
Silica	-	-	-	-	-	-	0.03

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1000.00

Of the above substances those in italics contain nitrogen. It is worth while to consider the composition of these bodies with regard to the other elementary constituents.

Urea consists of	N2+C 2+O2+H4
Uric acid	N4+C10+O6+H4
Ammonia	N1 . . H3
	<hr/> N7. C12. O8. H11

As there are 100 atoms of nitrogen in the formula of fibrine (6), we may elevate the nitrogen in the above sum to that number, preserving the form in regard to other elements—the process gives nearly N100, C171, O114, H157. This calculation is based on the supposition that the quantities of the azotized bodies in urine, are in proportion to their atomic weights—such, indeed, is not the case, but the proportion of nitrogen is higher, for of the substances enumerated, urea and ammonia constitute nearly the whole, and the former contains little carbon, whilst ammonia is without any.

If we contrast the ratio of the elements to each other, in the table, with

the composition of fibrine, we cannot fail to be struck with the large amount of nitrogen in comparison to the carbon; whereas in fibrine they are as 1 to 8; in urea they become as 1 to 1; in uric acid as 2 to 5, and in ammonia the carbon is absent. These proportions will not be lost, whatever be the relative amount of the different urinous compounds.

So far, then, urine is a much more azotized product than fibrine, and on the ground that it results from the decay of the latter, a large quantity of carbon is unaccounted for.

12. If the water of urine be taken into the account, as it should be, an additional amount of oxygen and hydrogen are separated from the elements of fibrine. What the exact amount of water produced by the combination of its elements derived from decaying fibrine may be, is uncertain, for water drunk by the individual escapes by the kidneys also. This much is, however, certain, that just in proportion as the oxygen and hydrogen are separated from the components of fibrine, the excess of unappropriated carbon increases.

13. Nor can we escape the conviction that the kidneys are not destined to separate this element by discovering the presence of lactic acid ( $C_6 + H_4 + O_4$ ) and lactate of ammonia in urine. Lactic acid by the formula contains  $1\frac{1}{2}$  times as much carbon as oxygen, but in fibrine the ratio is as 10 to 3; if, therefore, a sufficient quantity of lactic acid were present, to consume all the oxygen of fibrine, 440 atoms of carbon would be still ununited. This acid is by far the most highly carbonized constituent of urine. But as there should be no doubt left on the mind, as to the office of the urinous excrement, it is proper to observe that lactic acid is not a product of the decay of fibrine. Purely carnivorous animals eject uric acid principally, serpents only urate of ammonia. The presence of lactates arises from the decay of bodies of the starch family remotely, or of the oleaginous family approximately.

14. There remain the saline matters of urine; phosphate of lime and magnesia are proper to fibrine. Phosphate of ammonia is generated by the oxidation of the atom of phosphorus of fibrine, and the subsequent union of phosphoric acid with ammonia of the decaying matter. Part of the sulphuric acid is also the result of the oxidation of the two atoms of sulphur. The remaining saline matters are derived from other proximate substances, and from salts taken with food.

The presence of mucus in minute quantity is to effect a further decay of urea and uric acid. These substances, when chemically pure, are stable, but in the presence of putrefactive agents and oxygen, are resolved into ammonia and carbonic acid.

15. Upon a thorough investigation of the history of each constituent of urine, we are still left with a large quantity of carbon after the separation of every other element. It is unnecessary to trace the separation of the hydrogen; for in all the foregoing products of decay, urea, uric acid, ammonia, and water, it is present in high proportion.

16. Perspiration is another form of excretion by which a part of the products of decay leaves the body. It usually puts on the form of vapour in passing from the skin, but when exhaled in large quantities, or in an atmosphere, with a dew point approaching 90° F., it becomes fluid. In both conditions, as insensible perspiration or sweat, it has been chemically examined;—the former by Thenard and Anselmino, the latter by Berzelius and Anselmino.

17. Perspiration consists of water holding in suspension saline matters, a little animal matter, and carbonic acid. Some of these substances are volatile, others fixed. As long as insensible vapour only passes, the volatile portions escape from the skin, but leave behind a pellicle of saline matter, which forms the scurf of persons negligent of cleanliness. An accumulation takes place, especially in the armpit and groin, from the activity of the cutaneous glands in those regions of the body. In sweat the fixed salts flow off in solution.

18. From the examination of Anselmino, reviewed by Berzelius, we learn that 100 parts of sweat contain 0.5 to 1.25 per cent. of substances not volatilized by a water-bath. This great difference depends upon the quantities of water drank. Of the solid matter 22.9 per cent. was indestructible at a red heat—making 0.114 to 0.286 per cent. of saline matter in sweat. The salts are carbonate, sulphate and phosphate of soda, with traces of similar potash salts, chloride of sodium, carbonate and phosphate of lime, and a trace of oxide of iron. The carbonates of this list are the remains of incinerated lactates.

Among the volatile substances are lactate of ammonia, and an oil possessing the peculiar odour of the animal.

Carbonic acid, in a free state, was found in minute quantity by Anselmino; Collard de Martigny subsequently discovered nitrogen and hydrogen, but in uncertain quantities. The nitrogen has been traced by Læbig to atmospheric air taken into the stomach with saliva. It is apparent that where large quantities of water are drank, the nitrogen and carbonic acid must escape through the skin and lungs. Those who visit sulphur springs are aware of the exhalation of sulphuretted hydrogen by the epidermis. These minute quantities of gas are not, however, the product of decaying fibrine; for, with the exception of water, carbonic acid, and ammonia, the results of its metamorphosis in the system are dissimilar from the products of putrefaction. Both urine and perspiration are thrown out of the body with a portion of animal matter (mucus), that the final steps of decomposition may be accomplished out of the frame. Food, especially that which has commenced to ferment or is very prone to change, may liberate gas in the intestinal canal, but this has no connection with the metamorphosis of tissues.

The principal constituent of perspiration is water; no doubt a portion of it is drawn from the oxidation of the hydrogen of fibrine, but the greater part must be derived from fluid taken into the stomach.

Little of the surplus carbon is separated; for, although carbonic acid is a constituent of its excretion, and oxygen may be absorbed by the skin, both these actions take place to so limited an extent that it has hitherto been considered too unimportant to be measured.

19. It may be proper, before entering on the study of the excretion of the lungs, to make some remarks on the mucous membrane of the intestinal and urinary apparatus. These have been regarded as the internal skin by many physiologists. If such be the case, should we not look upon it as an excreting surface, and enumerate its products with those of the kidneys and lungs? But that this is not incumbent upon us will appear from an examination of the matters thrown out by these mucous membranes—not where they are full of glands—but in the most simple state, as in the male pelvis. If any notable excretion were thrown off the mucous membrane of the urinary system, it would be found in urine. Yet, upon examining that fluid, we find only 0.032 per cent. of mucus which has not been derived from the kidneys. The office of the mucus has been explained; it is not an excretion, but secretion.

It may be imagined that, notwithstanding the absence of excretion in the urinary mucous membrane, the quantities of mucus, or fluids evaporating from other portions of the tissue, may be considered excrementitious. This speculation can be readily disproved. If the lining membrane of the intestinal canal throws off any quantity of fluid, it cannot be in the form of vapour, but as liquid, inasmuch as the perfect saturation of the gases contained in the canal renders the process of vaporization impossible. The hypothetical fluid produced in the upper parts of the tube, as the œsophagus, running downwards into the stomach, would be absorbed by the spongy tissue of that organ in the same way as water. But the absorption of excretions is unnatural, and contrary to the laws of the organization. With respect to the fluid excreted according to this hypothesis in the small intestines and colon, omitting the certainty of absorption, unless produced in immense quantities, it is evident that in a state of health the stools containing so much fluid should be watery! How certainly absorption of liquids takes place may be gathered from the well known facts, that persons suffering from constipation, eject indurated fæces; and injections of soups, &c. into the rectum, have served to maintain life in cases of lock-jaw, &c. for weeks.

But if the excretion of a quantity of fluid were a function of the mucous membrane, what fate would await the lungs of persons resident in moist tropical countries? Vapour of water exists in expired air, but it is not necessarily an excretion of the mucous membrane. The amount of vapour derived from the lungs, is directly as the drying power of the inspired air, which proves it to be no more than an exhalation of moisture produced on mechanical principles. Thus if the dew point of inspired air be 98° F., the passage of vapour from the surface of the mucous membranes becomes nothing. Or, in other words, if we allow that the secretion of fluid is a



function of the mucous membrane, we must likewise admit that in health the action may be suspended for months without any apparent disturbance. This amounts to an absurdity. Another consequence, no less unnatural, attends the assertion that mucous textures excrete a fluid; if the function existed, a dew point of 98° F. would not arrest it; how is it with the epidermis, under that atmospheric condition, perspiration ceases, but copious and compensating sweat is produced? So in the lungs, *sweat* or fluid should be formed sufficient to counteract the pressure of the dew point. Does any one believe that it is so produced?

The halitus of mucous membranes, and the moisture of expired air, are, therefore, not excretions, but owe their origin to mechanical causes.

20. If we turn our attention to the solid dejections, we find no evidence of intestinal excretion. The solid itself consists of those portions of food which are insoluble in chyle, in excess, or innutritious, and therefore not appropriated by the system—we find no mucous excretion. It is not in the excrement of an over-fed luxurious gourmand we are to expect this result, for in such cases an irritation of the lining membrane of the larger intestines may cause them to throw out an abundance of mucus. But turning to the lower animals, let us examine the character of the *fæces* of a healthy dog fed on meat and bone—it is well known to consist of a white friable substance called album græcum by the older pharmacopolists, and yielding on analysis scarcely any thing but the inorganic matter of bones, (phosphate of lime,) which is insoluble in chyle. In the case of carnivorous birds, also, we find nothing but the urate of ammonia, with inorganic matters as excrement, a trace of mucus sufficient to produce decay, being added as in the case of urine.

21. These facts are of deep interest to physiology, not only as proving that there is no such thing as mucous excretion, but also in their bearing on the important question of the office of bile, which is still considered an excretion by medical men. On this subject I may now pronounce a decided opinion, that bile is not an excretion, or in any way concerned with the ultimate decay of fibrine. The proof is found in its entire absence in the preceding cases; but in addition to these, it was my misfortune, some years since, to lose a friend by death, whose ductus communis choledochus had been obliterated by the passage of biliary calculi eight months before his decease. During the whole of this time no bilious secretion was thrown into the bowels, and yet he enjoyed a tolerable amount of health. The further history of the case I will communicate in this journal on another occasion.

It is not my object to assert that bile may not be found in any specimen of excrement. Berzelius gives 0.9 per cent. of it in a specimen of human *fæces* examined by him. But its presence indicates that the quantity formed by the liver is too great for re-absorption, or that some other disturbing cause

is in action; and considering the great irregularities of men in taking food, this is probably a frequent case.

22. There remains but the pulmonary excretion to carry off the surplus carbon left from the decay of fibrine, (15). To this office it is destined. The carbon has, however, to be converted into carbonic acid to render its escape practicable. Hence the absorption of oxygen from the external world becomes necessary. In addition to carbonic acid, expired air contains a varying quantity of vapour of water, and sometimes a minute increase of nitrogen. Of the former I have spoken already; the latter derives its origin from air taken into the stomach with saliva or water, and is not a product of decay.

The lungs are at once destined to excrete carbon and absorb oxygen gas—but the union of these elements to form carbonic acid does not take place to any great extent in the pulmonary apparatus, but in numerous points in every part of the body where fibrine and other animal bodies are undergoing metamorphosis; the acid thus formed is conveyed to the venous system, and subsequently thrown out by the lungs.

23. The entrance of oxygen, under these circumstances, into the circulation, has been a subject of much debate amongst physiologists. We have not time now to discuss the many ingenious hypotheses, advanced in favour of and against this view. They are all subject to grave objections, and I should have dismissed the matter, had not Professor Mulder's paper on the oxidation of protein reached me in time. From his analytical researches, it appears that protein, which is fibrine without its saline matter, is oxidized in the lungs by the reception of three equivalents of oxygen, and becomes  $C_{40}H_{32}N_5O_{15}$ . In this way the oxygen is carried to every part, and wherever there exists a chemical affinity requiring that element, the fibrine abandons it probably at the loss of its soluble state. In other words the conversion of oxygen by fibrine is attended with two results, the simultaneous supply of the gas to atoms undergoing *eremacausis*, and the deposition of fibrine in the proper point as a substitute for the loss. Hematosin is also recognized by Mulder as a means of distributing oxygen. The view of Liebig that the means was the peroxidation of the iron of blood is unworthy of that splendid chemist.

24. We are now prepared to answer the query proposed—What is the character of the decay fibrine undergoes within the animal body, in its ultimate change? The features of putrefactive fermentation and complete *eremacausis* (6) have been given; to neither of these processes does the change belong. Neither gaseous carburets, sulphurets, or phosphurets are produced as in fermentation, nor is all the carbon converted into carbonic acid, and the hydrogen not consumed in forming ammonia united with oxygen to generate water. The former of these compounds marks a minimum of oxygen, the latter a great abundance. Time is an essential element in these changes, for

if the action be reduced to a minimum, abundance of oxygen being present, a portion of the nitrogen will also be oxidized or converted into nitric acid.

The decay of fibrine in the frame is also dependent upon the oxygen, but takes its character neither from excess nor deficiency of supply. The reason is to be found in the capacity of the lungs. To convert all the carbon into carbonic acid and 320 atoms of hydrogen into water, would require the absorption of 1680 atoms of oxygen more than the fibrine contains; but by separating a portion of these elements in the form of urea and uric acid, the amount of oxygen necessary for metamorphosis, is considerably diminished. The lungs cannot, under ordinary circumstances, supply sufficient oxygen for complete eremacausis.

25. That the capacity of the pulmonary apparatus and frequency of respiration are the true causes of the peculiar decay or sub-eremacausis of the living frame, is proved by the changes which occur in the products of the urine. The amounts of urea and uric acid are perpetually fluctuating. In persons who are active, urea is considerably in excess, or the sole result, while in sedentary persons, and those who suffer from confinement, uric acid increases in proportion. Urea contains more oxygen than uric acid, for urea equals  $C_2H_4N_2O_2$ , or carbon 2, oxygen 2, and uric acid,  $(C_{10}N_4H_4O_6)$  only 6 of oxygen to 10 of carbon.

26. It is unnecessary to state that the decay of parts is essential to the welfare of the whole—that upon the cessation of atomic metamorphosis, the destruction of the system ensues. The nature of the decay we have reduced to one primary condition, the amount of oxygen entering the body, but there are disturbing causes which control the quantity, and direct the metamorphosis of parts. These are, frequency of respiration and the nervous power. The balance of these three component forces cannot be disturbed without the production of change, which may eventuate in disease. Let the respirations become greatly increased, larger amounts of oxygen enter, the fibrine in the blood is converted in excess into the tritoxide of Mulder, which is identical with the *buffy coat of the practitioner*, the transfer of the oxygen therefrom to various parts of the body, exalts the temperature by hastening the changes of metamorphosis, more urea is produced (Prout)—in other words, a fever is the result.

27. The amount of oxygen entering controls the result. If, then, the nature of the decay be dependent upon an external agent, what is the influence of vitality in the process of metamorphosis? In other words, is this a case of vital change, produced under peculiar laws, independent and superior to chemical laws, that is by the vital force? I answer it is not, that the process is purely chemical, and subject to no disturbance whatever; the places where change takes place in the economy, are regulated by other causes, not by the admission of oxygen only, but the products of decay are formed solely under the agency of chemical forces. There is no difference between the decay of fibrine necessary to health, and external decay, con-

ducted in such a manner as to yield urea, uric acid, ammonia, carbonic acid and water. The real difference between the metamorphosis of animal matter and similar external decomposition rests in this important particular, that in health the removal of one atom of fibrine is attended with the deposition of another, capable of performing the same function—this timely and essential addition is the work of what may be called the vital force, for upon it vitality depends.

28. Therefore the fibrine of the bodies of animals is subject to a peculiar decay, depending upon the access of oxygen, and being a sub-eremacausis whereby urea, uric acid, ammonia, water, and carbonic acid are produced. This may be termed *vital eremacausis*, because activity depends upon it, and as a means of separating the change from putrefaction, and complete eremacausis.

Vital eremacausis owes its character to the circumstances—that it occurs at a fixed temperature, 98° F., that the supply of oxygen to the amount of fibrine changed is rigorously limited, and the time in which it takes place is also determinate. Alter any of these conditions, and the nature of the decay changes; there is nothing specific in it; the amount of change may bring about disease, but if radically altered, death is the result.

Nor am I chargeable with examining the effect instead of the cause. Fibrine, as such, whether in the texture of an animal, or in the laboratory, like every other definite chemical compound, is so constructed that its atoms are in equilibrio,—it has no innate power of change, but when removed from external agencies may remain *fibrine* to eternity. It is altered only by external causes, and the product depends upon the cause. In the human body, the causes of change are oxygen and moisture; these, therefore, must be present primarily, or, in other words, inspiration of oxygen is the first act of existence.

The metamorphosis of matter is, therefore, the cause of activity, for no particle of fibrine undergoes decay without the production of those molecular forces which are the producers of heat, light, electricity, and other effects. If the metamorphosis is hastened, as by the use of protoxide of nitrogen, or by rapid inspiration, the activity is heightened—in these cases, an increased quantity of oxygen enters in a given time, but must be appropriated; it cannot be rejected as an element from the system, and it therefore acts upon more atoms of fibrine.

It will be perceived, however, that the oxygen diffused throughout the economy by the blood, has not the power of spontaneously deserting the fibrine (with which it is combined, according to Mulder), but does so only under the influence of molecular forces. Were it otherwise, the oxygen would act exclusively upon the first atoms of fibrine it encountered—but we know that changes may become much more active in one part of the body than another, without respect to its distance from the lungs. There is, therefore, a power which protects one atom of fibrine, whilst it exposes

another to decay. Without the existence and recognition of this force, the action of oxygen would be destructive instead of sanative, and no chemical theory is tenable without it. What the force is, or whence it originates, is not for discussion now; there is no question that it manifests itself through the nervous system. It has nothing to do with the products of *eremacausis*, for whenever an atom is abandoned to the action of oxygen, chemical forces only come into operation.

It may be agreeable to call the directing force vitality or vital force, for it undoubtedly regulates waste and supply, directs motion and growth, but it does not act in violence to chemical or mechanical forces.

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ART. II.—On *Cyanosis*, or *Morbus Cæruleus*. By MORETON STILLÉ, M. D.\*

CYANOSIS, or *Morbus Cæruleus*, by either of which terms the disease we propose to treat of is sufficiently well designated, had not attracted, until of late years, much notice from medical writers. It is indeed true, that cases of the disease are to be found scattered through the periodical works of the last century, and that, as faithful portraits of its more striking features, they are unexceptionable; but we have to regret their imperfect description, in many instances, of structural alterations, and often the entire want of any account of these conditions. Had the value of these signs been always duly appreciated, the knowledge of the true pathology of the disease would not, perhaps, have been so long obscured, and the ingenuity expended in the support of fanciful hypotheses would have been more usefully employed in legitimate inferences from well ascertained facts. Several treatises on cyanosis, and chiefly from the pens of the French and German writers, are now extant, and have been regarded as containing all that was known of its pathology. The doctrines advocated in them have received a general and tacit assent, but we think that they will be found to be the offspring of a too narrow observation, and to embody speculative notions rather than sound principles.

The first approach to a more correct mode of investigation was made by M. Gintrac, of Bordeaux, who, in 1814, wrote an inaugural thesis upon this subject. Ten years after its publication it was again issued, in a more complete form, M. G. having, in the mean time, much extended his researches, and somewhat modified his opinions. His essay contains the history of 53 cases of cyanosis, collected by him from various works, some of which were rare, and difficult of access. M. Louis, in 1823, published a

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